Appropriate and economical subscriber access is critical to the introduction of suitable networks throughout the world in the 1990's. The objective of each network is to provide the required services to the subscribers in the most economical way and yet with the maximum opportunity to exploit future growth in the subscriber base through technological change and the introduction of new services.

We have seen the introduction of many different network types over the past half decade and as we increasingly move towards wireless as a method of quickly satisfying requirements in economies which have not had the benefit of traditional cable systems we also see an increasing requirement to have a variety of RF subsystem solutions available for application in developed economies.

Subscriber access in the 1990's is key to the strategic well being of all carriers. These networks provide the basis for economic growth and general community development. Some years ago traditional wireless access was used only for access of rural and remote subscribers of countries capable of incorporating the infrastructure within their general communications network. However the past five years has seen the growth of the economies of various developing countries and the new directions of equipment manufacturers in an attempt to satisfy requirements for more mature needs in developed countries, particularly in the context of heavy deregulation around the world. This deregulation be spawned a plethora of alternate carriers each keen to directly reach its customer base.

We have seen an increasing move to various specific solutions for different kinds of telecommunications problems. For instance five years ago, we saw point to multipoint solutions available from a number of manufacturers dimensioned to support relatively low-subscriber-density remote and rural access only, but incapable of supporting the increasing requirements of the urban subscriber.

Traditionally these point to multipoint solutions were connected to the main telecommunications network via a microwave backbone system. The point to multipoint link may have been direct radio to the subscriber or it may have been radio to a hub from which a copper network was then distributed to the subscribers premises.

In the mid 1990's we now see the market divided into a number of different subscriber access methods; point to point and multipoint microwave still exists and this is important for gaining access to both rural / remote and urban areas where existing inground infrastructure is inadequate to handle the volume and types of new services. Additionally we see the introduction of specific technologies to support the higher demands of urban areas which do not have access to terrestrial cable networks, predominately stimulated by rollout requirements in competitive situations.

These technologies range from the previous mentioned point to multipoint technologies dimensioned for lower duty rural and remote applications through to the new wireless local loop technologies aimed at addressing significant amounts of subscribers in dense urban areas. In between these two technologies we find the use of cellular applications being somewhat modified under the new name of "fixed cellular” to provide a fill in between the capacity ratings of the traditional rural and remote systems and the new wireless local loop systems. These fixed cellular operations are being provided in such technologies as AMPS, GSM and CDMA at various frequencies ranging from 800 MHz through to a few GHz.

**RF Subscriber Access**

The diversity of the new network technologies delivering increasingly sophisticated services to the remote / rural and urban subscriber has meant a matching requirement in the development of suitable RF subsystem technology to support the capacity and price point expectations of suppliers and the ultimate subscribers. The system architecture is predicated upon the population density, concentration of population, traffic patterns, growth rates, services and the length of service required.

Radio Frequency Systems has traditionally operated in the remote and rural market as well as the
microwave market and it was a natural extension to meet the new market technology requirements of wireless local loop and fixed cellular. The offerings that RFS provides are specific to each market segment.

**Point-to-Point access - Microwave**

**Subscriber**

Key Subscribers such as major Government and corporate clientel have traditionally been provided secure temporary or permanent links via microwave spurs from the main telecommunication centres. This is functional but is relatively uneconomic due to the equipment cost/volume not realizing a true subscriber-like product.

**Trunking**

Point to Point Microwave has had a major role in all major wireless projects as the conduit for providing efficient, effective trunk capacity between remote concentrators, multiplexers and the main stations, or between major switching centres as a backbone.

Capacities range from 2 Mbps or lower up to 140Mbps, and even include compatibility with SDH networks, traditionally only associated with the superior error performance of optic fibre.

Point to point microwave operates as low as 400MHz using antenna subsystem such as the RFS Gridkit range of grid antennas. These antennas are shipped in kit form and assembled on site and provide excellent performance from 400 KHz to 2.7 GHz in networks worldwide, particularly in the SEAsia region. A key element of antenna selection is electrical performance, mechanical strength and ability to survive winds to cyclonic levels.

**Wireless Local Loop**

The Wireless Local Loop products that are being released by the various major vendors around the world operate in a number of different frequency bands dependent on the manufacturers technology and their perceived ease of access to frequencies within their target geographic areas. To this end we see manufacturers producing fixed cellular in AMPS, GSM and 1.8 and 1.9 GHz frequencies and in some cases as high as 3.4 GHz.

These differing frequency bands and different transmission technologies on the RF interface or the air interface mean that the specific RF subsystem is different for each. In the case of wireless local loop access at typically 800 or 1.8 GHz, the traditional access method would appear to be based on AMPS, DECT or PHS systems (Digital European Cordless Telephone and Personal Handi Phone System). These systems are the result of various standardization processes in particular areas of the world and have been able to come up with multi vendor compatibility within the air interface. This means that the network operator is able to gain interworking and competition in product sourcing for standardized transmission equipment. At the RF air interface this means that various requirements to provide coverage based on the traffic expectations of AMPS, DECT or PHS and to control intercell interference based on the sensitivities of each technologies.

For the RF equipment stand point the use of wireless local loop operating at 800 or 900 MHz traditionally requires the use of directional antennas in order to balance coverage with traffic density. Typically these needs can be met by the RFS DPS family of antennas which range from low side lobe fixed electrical tilt antennas through to the very special continuously variable electrical tilt antenna. Antennas of this type enable operators to run AMPS, GMS or CDMA in the 800 or 900 MHz bands with the knowledge that they can control intercell interference to worlds best levels through the use of either extremely low side lobe fixed electrical tilt technology or the RFS patented variable electrical tilt technology which provides even greater flexibility during network growth. Both these antenna technologies have been proven in the land mobile market in traditional cellular mobile systems and have been modified where necessary to suit the applications of the wireless local loop.
Given that wireless local loop is essentially targeted at the higher density urban areas some of the inputs into the design of the RF subsystem are the amount of hardware and one of access to real estate. It is increasingly difficult for operators to gain licencing approval for installation of a typical 3 sector, nine antenna installation in urban areas due to visual and real estate acquisition problems. Accordingly there is availability of antenna reduction techniques through the use of dual polarization. Here the traditional land mobile cellular antennas are modified to incorporate the ability to operate on two orthogonal planes of polarization within the one antenna. This has the effect of reducing the antenna count with the benefits of lower wind loading on towers and more discrete antenna sites. For example a typical land mobile cellular system currently uses three antennas per sector and three sectors per cell. One antenna of the three is used for transmit, either AMPS or GSM typically, and two antennas are used on each face for receive diversity. In order to get sufficient decorrelation between the two receive antennas the antennas are separated by around three metres. This results in a typical cell site that we see around the skyline of many countries of the world today, which has a sector face of about 3 metres and a platform area on a cellular tower of around the 9 metres on an equilateral triangle. The use of the dual polar approach appears to reduce this to a single antenna per face.

This development in the cellular market also applies in wireless local loop systems.

**Rural and Remote**

**Fixed Cellular**

The term fixed cellular is applied to the use of existing mobile cellular technology to meet the needs of a different market, that of the fixed telephony/fax subscriber.

Fixed cellular is offered in a number of ways. Firstly, as an overlay to the primary use as a mobile network. For example, it may be more effective to provide similar access via the mobile network along a highway in rural area than specifically install an alternative network.

Normally, fixed cellular may be a modified cellular system, having only the key radio and switching elements but not typical mobile facilities; such as handover.

RF subsystem access products need to be economic and technically reliable to achieve the grade of service required. Generally, antenna systems are omni, such as the RFS A9009 9dBd collinear, or directive such as the DPS family of cellular panels or, for the subscriber end, a lower cost yagi such as a YS8 8dBd yagi.

**Point to Multipoint**

The more traditional application area for wireless subscriber access is the rural and remote area where RFS has been active for many years in providing point to multipoint and microwave solutions worldwide. The structure of a typical rural network is to provide access to the main infrastructure via microwave either medium or high capacity and through a networking hierarchy eventually end up at a point to multipoint system servicing somewhere around a few hundred to some hundreds of users. These are typically operating in the traditional rural bands which are around the 1.5 GHz, 1.8GHz, and 2.3 GHz areas. The types of RF subsystems available in these areas consists of highly directional antennas, such as grids, corners and the like, through to more economical yagis or directional antennas and various gain omnis for the central station sites. As indicated before, systems from various manufacturers use different techniques to get to the subscriber such as direct RF access to the subscriber or alternatively access to a local hub and copper to the subscriber. The types of services offered range from relatively simple telephone access for voice communications through to low speed data and facsimile at around 4800 bit per second through to ISDN access dependent on the capability of the trunk and the subscriber units.
RF subsystems supplied by RFS have included such projects as the Telecommunications Organization of Thailand rural project supplying point to multipoint services to over 4000 villages in Thailand and the Telstra rural and remote projects known as the Digital Radio Concentrator Service and the High Capacity Radio Concentrator Service. The former operates at 500 MHz and the latter operates at 1.5 GHz. The ability of the RF subsystem to support the reliability requirements of the subscribers and the operators of the network is critical. Accordingly RFS uses quite sophisticated design and manufacturing techniques to achieve the reliability required and this has been proven in many networks throughout the world. In particular, where antenna systems are actually carrying multiplexed subscriber traffic and therefore a failure affects more than just one subscriber. This point actually is the essential break point between the two technology types that are required for RF subsystems in subscriber access and the trend appears to be that where a single subscriber is being served by a point to multipoint system a lower level of cost and performance expectation is built into the subscriber end than is the case in a multiplexed system where many different subscribers are affected by the same antenna system. Accordingly the RFS range divides into essentially the same two divisions with low cost economic subscriber access type antennas and feeder options and the more sophisticated multiple end channel antenna options and increasingly higher performance cable and filtering options for the network.

**Microwave Point to Point Links**

**PCN**

PCN technology is relatively new and is generally being applied to urban areas following regulatory and channel clearing programs. However, in competitive environments PCN is typically the vehicle of a second or third operator and the need to address both mobile and fixed subscribers should stimulate a model similar to fixed cellular. It is not yet clear how the balance of cost / benefit in terms of subscriber density, traffic and services will affect the access component of the RF system. As a result, it is unclear if the range of RF equipment available for the PCN market is directly relevant and appropriate in a PCN/rural/remote application. Evaluation of any required development and specification analysis is underway at present.

**Satellite**

Satellite has traditionally been a tool for remote access but at a high initial cost. Recent advances in transmission technology have gradually brought the price down. These technologies include SCPC, TDMA and DAMA. Each technology progressively lowering the resources required to provide a two way circuit to the extent that commercial nationwide services a readily available in most countries.

A more recent advance has been the development of L-Band mobile telephone services such as the Optus Mobilesat ® in Australia or AMSC Mobilesat ® in the USA, Canada and Mexico. These services do not yet achieve the price point sought by rural and remote service providers but do provide an instant solution to short term services.

**Conclusion**

The 1990's is a decade of unprecedented change as almost all countries attempt to establish competitive market structures and meet user demand for easy availability, newer technology services.

Wireless is a major medium to deliver this change independent of existing infrastructure, typically that of an incumbent ex-monopoly. The wireless RF subsystem is a critical component in meeting the price /performance expectations of users and operators and RFS, as a major global player in the RF market continues to provide and support innovative solutions to these new technologies.

Radio Frequency Systems is a major national and international end user and OEM RF equipment and turnkey system provider. It assist clients by providing RF technical expertise, consultancy solutions and products worldwide.